Chapter 5 CONTROL MEASURES

5.1 Introduction

This chapter briefly discusses the control measures for improving visibility in order to assess illustrative regional haze (RH) progress goals in this regulatory impact analysis (RIA). The Environmental Protection Agency (EPA) has attempted to identify and develop cost and emission reduction estimates for control measures covering nearly every source category with sources emitting pollutants that contribute to visibility impairment. The measures discussed in the chapter consist primarily of controls already in use, and are intended as illustrative of measures that may be selected to reach progress goals chosen by States or local areas. Generally, the measures involve more conventional control approaches (e.g., "add-on" control devices installed by an air pollution source) that are proven effective at reducing air pollution. Pollution prevention measures such as material substitution, source minimization, and fuel switching are also considered when it is cost effective to do so. Several less conventional measures are also included, such as education and advisory programs, sulfur dioxide (SO_2) emissions trading programs for utilities, and transportation control measures designed to slow growth in vehicle miles traveled (VMT). Technologies emerging now, or to be developed in the future, will likely play a key role in attaining the progress goals 10 to 20 years in the future. These new technologies may be more cost effective than control measures analyzed in this RIA, but have not been included in the analyses presented in Chapter 6 due to lack of control efficiency and cost data for inclusion in the control measure database.

In this analysis, five major emitting sectors are delineated: 1) utility point sources, 2) non-utility stationary point sources, 3) stationary area sources, 4) on-highway mobile sources, and 5) nonroad mobile sources. For each of these source categories, a variety of control measures for primary particulate matter (PM_{10} and $PM_{2.5}$), $PM_{2.5}$ precursors (SO_2, nitrogen oxides (NOx), volatile organic compounds (VOC)), ozone precursors (VOC, NOx), and RH contributors (primary PM, SO_2, NOx, VOC, secondary organic aerosols (SOA), organic carbon (OC), elemental carbon (EC)), have been analyzed[1]. The list of control measures included in this analysis is not exhaustive. Many other control measures may exist, but are not included in this analysis because: 1) the EPA is not able to obtain reliable cost and/or emission reduction estimates; 2) at a specific source, another control measure is identified that achieves equal or greater control efficiency at equal or lower overall cost; or 3) the measure is not currently being implemented for administrative reasons.

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[1] Controls for ammonia emissions were not included because: 1) ammonia emissions are not a particle-limiting pollutant in the formation of $PM_{2.5}$, and 2) ammonia emissions in the National Particulate Inventory used in this analysis are more uncertain than emissions of VOC, NOx, SO_2, and primary PM.

It should be noted that the contribution of VOC and PM control measures to reducing OC and EC emissions is now considered in the RH optimization routine. The analyses for the proposed RH target program did not account for this contribution. The contribution to control of EC is particularly important since elemental carbon emissions are a major contributor to visibility impairment in some Class I areas (U.S. EPA, 1998b). This adjustment to the RH optimization model renders VOC and PM control measures of greater importance in the choice of control measures for decreasing visibility impairment.

Appendix B contains a table listing the control measures employed in the RH emission reduction and cost analyses. This table indicates the emissions source category that is impacted. For this analysis, all cost and emission reduction estimates for a given control measure are calculated incremental to controls already in place, or incremental to the next less stringent new control measure. As shown in Appendix B, several control measures achieve reductions in more than one pollutant. This is important in that there may be more cost-effective approaches to obtaining progress towards a visibility goal by implementing programs to reduce multiple pollutants than focusing on a single pollutant.

The application of some control measures may result in cost savings (i.e., negative average annual incremental cost per ton values). In these cases, the estimated cost savings are due to the recovery of valuable products or switching to technologies with lower long-run operating costs. One example of this occurring is VOC control measures that limit evaporation of solvents in open-top vapor degreasers. Where these control measures are selected, the estimated savings are credited. Further, some control measures are assigned a zero incremental cost per ton. These measures involve either a long-run transition to a substitute technology with equivalent capital and operating costs, or behavioral change-inducing public information programs for which cost information could not be found or easily developed.

In developing control efficiency estimates, it is assumed that control measures on average achieve 95 to 100 percent of their intended effect. The EPA currently allows States to develop alternate rule effectiveness methods for control measures included in State implementation plans as long as they follow certain basic requirements as described in the 1992 and 1994 guidelines for rule effectiveness (U.S. EPA, 1992b and 1994). The EPA has routinely accepted plan provisions with 95 to 100 percent control measure effectiveness assumptions.[2]

The degree of effectiveness applied to each measure depends on a variety of factors including the extent of monitoring and recordkeeping requirements, difficulty of control

[2] There is the possibility that rule effectiveness may not be 100 percent for area and mobile sources. However, it is very likely that RH rule effectiveness will be 100 percent for all sources since capture and collection efficiency and the performance period will be reflected in the design of this rule.

equipment maintenance, extent of over-control achieved by "margin of safety" engineering, and gross noncompliance (PQA, 1997). Generally, stack pollutants like NOx are more easily measured and monitored than, for instance, PM_{10} emissions from wood stoves (residential wood combustion). For that reason, some NOx control measures may be expected to have a higher control measure effectiveness than some VOC control measures. Also, it may be easier to enforce effectively a handful of point sources than a large number of area sources. For that reason, control measures affecting a small group of point sources may have a higher control measure effectiveness than measures affecting a large group of area sources.

In order to derive county-specific cost and control efficiency estimates for mobile and area source control measures, it is necessary to estimate the degree of *rule penetration*. In this context, rule penetration refers to the percentage of the county-level mobile or area source emissions inventory that is affected by the control measure. As used here, rule penetration effectively accounts for applicability constraints, such as size cut-offs. For example, a penetration rate of more than 90 percent indicates that the control measure applies to nearly every major emitting source within the source category. Conversely, a penetration rate of less than 10 percent indicates that only a few emitting sources may be affected. Rule penetration estimates generally are taken from published reports from State and local agencies.

The final emission reduction factor attributable to mobile and area source control measures is a combination of the estimated control efficiency, control measure effectiveness, and rule penetration. For example, an area source control measure with a 50 percent control efficiency, 95 percent control measure effectiveness, and 60 percent rule penetration rate, results in an emission reduction factor of 28.5 percent (0.5 * 0.95 * 0.6).

5.2 Utility Point Source Control Measures

Under the Clean Air Act (CAA), the EPA's primary focus has been further controls on NOx and SO_2. Table 5-1 summarizes the controls in the benchmark for the analysis of the final RH rule. This benchmark, which is estimated for the year 2015[3], assumes that all of the CAA's Title IV requirements are in effect, tighter new source controls are in place than exist in 1999 (based on today's best available control technology (BACT) decisions that have occurred in New

[3] 2018 is the end of the period for the first long-term strategy. The term “long-term strategy” refers to the set of emission reduction measures the State includes in its SIP in order to meet the reasonable progress goal it has set. 2015 is a nominal “snapshot” year that reflects the partial attainment control cases for the ozone and $PM_{2.5}$ NAAQS included in the baseline, and is near the end of the period for the first long-term strategy.

Source Review), and a NOx cap-and-trade program has been implemented in the 37 eastern States in the Ozone Transport Assessment Group (OTAG)[4].

The EPA examined a number of additional NOx and SO_2 control measures for the utility sector in the baseline for the final RH rule. These include more stringent NOx reductions for the utility cap-and-trade program in the OTAG States, and more stringent SO_2 reductions than what is called for in the nationwide Title IV utility cap-and-trade program. The EPA is including in the baseline for the final RH rule a cost-effective control strategy using existing technology that reduces the Title IV SO_2 emissions cap for utilities and large industrial boilers.

To meet existing Title IV requirements and the more stringent SO_2 cap (otherwise known as the National $PM_{2.5}$ Strategy) in the baseline, EPA has modeled the following SO_2 control options:

1. Scrubber Installation. New coal-fired units must install scrubbers in accordance with the NSPS, but do have some freedom on how much SO_2 reduction they obtain above the limitations in the NSPS. Existing units can install them. Those operating units that already have scrubbers can choose to increase the scrubber's performance levels to avoid purchasing allowances, or to free up allowances to trade with other operators of other units.

2. Fuel switching. Select coals or fuel oils with sulfur contents that will allow operators to minimize costs. Cost factors include the cost of scrubbers, the cost of allowances that operators may need to purchase if they continue using the same grades of fuel, and the prices of fuels with lower sulfur contents.

3. Repowering. Repower existing coal-fired or oil-fired units to natural gas combined-cycle, or switch to natural gas. (This choice reflects the fact that the units can simultaneously reduce NOx and SO_2 emissions to minimize the total cost of both sets of pollution controls.)

4 This program assumed a 0.15 lb NOx/MMBtu emission cap is applied to all utility sources in the 37-State OTAG region. The emissions cap is achieved through a program of trading NOx emissions allowances (hence, a "cap-and-trade" program). The 15 OTAG States in the fine grid that are not affected by the NOx State Implementation Plan (SIP) call promulgated in September, 1998 are Florida, Mississippi, Louisiana, Texas, Arkansas, Oklahoma, Kansas, Nebraska, South Dakota, North Dakota, Minnesota, Iowa, Vermont, New Hampshire, and Maine.

Table 5-1
Levels of Federal NOx and SO_2 Controls for Electric Power Generation in the Benchmark and the Baseline for the Regional Haze Control Strategy Analyses

Pollutant	Benchmark CAA Requirements and Baseline Measures for the Analysis of RH Control Strategy Analyses
SO_2	Existing units - Benchmark: Comply with the Acid Rain Allowance Trading Program under Title IV of the 1990 CAA with phased-in requirements. Phase I covers the largest 110 coal-fired power plants beginning in 1995. All other units above 25 megawatts are covered in Phase II beginning in 2000. Baseline: Comply with a 60 percent level of control applied beyond Title IV requirements (otherwise known as the National $PM_{2.5}$ Strategy). New units - Benchmark: Comply with the more stringent of New Source Performance Standards (NSPS) set in 1978, BACT/Lowest achievable emission rate (LAER) requirements, and the Acid Rain Allowance Trading Program under Title IV of the CAA 1990. Baseline: Comply with a 60 percent level of control applied beyond Title IV requirements (otherwise known as the National $PM_{2.5}$ Strategy).
NOx	Existing units: Application of Reasonably Available Control Technology (RACT) occurred in 1995 in the Ozone Transport Region and all ozone non-attainment areas. Many States filed for and received waivers from RACT requirements. Compliance by coal-fired units with the Title IV NOx requirements that are phased in over time, or RACT, whichever is more stringent. Group 1/Phase I units comply with the Title IV emission limitations in 1996. Group 1/Phase II units and Group 2 units comply with the Title IV requirements in 2000. Collective action of the 37 Eastern States in OTAG leads to further summer season requirements on NOx emissions throughout the eastern US via a cap-and-trade program. New units: Comply with the more stringent of NSPS, BACT, and the Title IV standards for coal-fired units, whichever is more stringent. Units are also covered by the OTAG requirements of a cap-and-trade program.

4. Natural Gas Replacement. Retire existing coal-fired, or oil-fired units and replace them with combined cycle natural gas units. (This choice also reflects the fact that units can reduce both NOx and SO_2 emissions simultaneously.)

5. Purchase Emission Allowances. Operate units so that they do not exceed allowance levels, or purchase of limited numbers of allowances.

Several types of hybrid actions are also possible. Notably, the modeling framework within IPM allows units to install both NOx and SO_2 pollution controls (under Title IV) together where it would economically make sense for a unit to do so. The costs and performance of scrubbers, repowering, and adding new capacity appear in EPA's Analyzing Electric Power Generation under the CAA (U.S. EPA, 1998a).

For the analysis of the partial attainment $PM_{2.5}$ NAAQS in the baseline for the RH rule, EPA has modeled a trading and banking control strategy that reduces the annual SO_2 emissions cap by 60 percent to 3.58 million tons in 2005. In this report, this control strategy is referred to as the National $PM_{2.5}$ Strategy. The National $PM_{2.5}$ Strategy is a 60 percent reduction beyond Title IV Phase II levels, and is achievable with existing control technology. It is assumed that lowering the SO_2 emissions cap would occur in 2005 and lead to nearly a 50 percent reduction nationwide of annual SO_2 emissions by 2010. Table 5-2 shows the regional emission reductions that EPA expects to occur by the analysis year 2015. Most of the SO_2 reductions occur in the Midwest/Northeast and Southeast control regions.

Table 5-2
Emission Reductions for National $PM_{2.5}$ Strategy:
60% Utility SO_2 Reduction from Title IV Phase II Levels
(thousand tons per year)

RH Control Region[a]	SO_2	NOx	VOC	Primary PM_{10}	Primary $PM_{2.5}$	SOA (tons per year)
Midwest/Northeast	2,789.0	108.6	(1.0)	4.4	0.6	18
Southeast	1,290.4	86.7	(3.0)	10.4	(0.1)	11
South Central	354.1	(9.0)	(0.2)	0.9	0.2	5
Rocky Mountain	72.9	8.8	(0.1)	0.1	0.0	3
Northwest	4.5	0.1	0.0	1.6	0.6	0
West	0.0	(0.1)	0.0	0.0	0.0	0
Nation	4,510.9	195.1	(4.3)	17.4	1.2	36

a See Chapter 6 for a discussion of RH Control Regions.

Since utilities are predicted to over control emissions initially and bank allowances for later use, the SO_2 emissions level in 2010 is expected to be 5.2 million tons, or a 47 percent reduction from the NAAQS baseline. The additional 13 percent reduction is expected to be realized sometime after 2010. The estimated annual control cost associated with this baseline control measure in 2010 for the electric power industry is $2.6 billion (1990$).

It is important to note that regional shifts in power generation due to utility deregulation, and regional shifts in emissions control responsibility due to emissions trading can mean that reductions in NOx and SO_2 emissions are not realized in specific locations. For instance, note that Table 5-2 indicates minor increases in NOx emissions in the South Central and West control regions.

5.3 Non-Utility Stationary Point Source Control Measures

The non-utility stationary point source category contains a diverse group of sources including combustion sources at various manufacturing operations and institutional facilities, larger surface coating operations, and process fugitive dust sources at mineral processing plants. Examples of stationary point source control measures include “add-on” stack controls (such as fabric filters and carbon adsorbers), process fugitive controls (e.g., wet dust suppression), and combustion modifications (low-NOx burners, etc.). Control costs for these measures are estimated at either the point source or source category level. Where sufficient source data are available for point sources, the cost is calculated using control measure and process size-specific cost equations based on a size indicator available in the emissions inventory. Examples of this indicator include stack gas volumetric flowrate and boiler design capacity.

Other point source emission reduction and control cost estimates are developed from information contained in published reports from State and local agencies. Every effort is made to verify that the estimates derived from these published reports are broadly applicable in a nationwide analysis, and that sound engineering cost procedures are used to develop the published estimates.

5.4 Stationary Area Source Control Measures

The stationary area source category also contains a diverse group of sources including smaller combustion sources at various manufacturing operations and institutional facilities, surface coating operations, and fugitive dust sources like paved and unpaved roads. Examples of area source control measures include combustion modifications (low-NOx burners, etc.), fugitive controls (vacuum sweeping and wet dust suppression), public education programs (the public awareness and education (PACE) program for residential wood combustion emissions), add-on stack controls (incineration), and VOC content limits for coatings and various consumer products.

Since the National Particulate Inventory (NPI) does not contain source-specific information on area sources, emission reduction and control cost estimates are developed from information contained in published reports from State and local agencies. In a few cases, the area source categories correspond to point source categories where control efficiency and control cost estimates are already developed. For example, the cost for low-NOx burner controls on industrial coal, oil, and gas combustion is adapted from low-NOx burner controls for industrial point source boilers. In these cases, the point source control efficiency and cost estimates, expressed in dollars per ton of pollutant reduced, are applied to the area source control. An effort is made, if appropriate, to use the point source data associated with the source size expected to be present in the area source category. Also for a few control measures, control efficiency and control cost estimates are transferred from similar, but not identical, applications. For example, the VOC control measure for metal can coating is transferred from industrial surface coating categories.

In this report, the RH illustrative progress goals are examined under two different emissions control cases: Case A, the case in which fugitive dust control measures are considered in the optimization routine; and Case B, the case in which fugitive dust control measures are not considered in the optimization routine. These control cases are described in more detail in Chapter 3. In Case A, the choice of fugitive dust control measures reflects the adjustment to baseline fugitive dust emissions described in Chapter 4. In Case B, the fugitive dust control measures are removed from the control measures database before the optimization routine begins. A list of these control measures is available in the *Addendum to Control Measures for Regional Haze Alternatives* (U.S. Environmental Protection Agency, 1999b).

5.5 Mobile Source Control Measures

The mobile source control measures employed in the benchmark and baseline for the RH rule are classified in two groups: national measures and local measures. Mobile source control measures that are based on changes in vehicle or engine emission standards are best applied at the national level. It would be expensive and difficult for vehicle and engine manufacturers to comply with a patchwork of standards applied at the local level, and, because motor vehicles and engines are mobile, much of the benefit of vehicle or engine emission standards applied at the local level would be lost to immigration of dirtier vehicles or engines into the local area. In contrast, control measures like vehicle inspection and maintenance (I/M) programs, cleaner burning fuels, and VMT management programs are more effectively implemented at the local level.

5.5.1 National Mobile Source Control Measures

Several potential mobile source control measures involving the creation of new emissions standards for on-highway and nonroad mobile sources were examined. Many of these measures, particularly those involving nonroad and heavy duty engines, have the potential to result in significant long-term reductions in NOx, VOC, and/or PM emissions.

The benchmark for the analyses in this report assumes the existence of a voluntary

National Low Emission Vehicle (NLEV) program. The NLEV program in the baseline is based on California emission standards that are more stringent than the standards required in the Clean Air Act (CAA) (“Tier 1" standards).

The baseline for the analyses in this report includes more stringent standards beyond the “Tier 1" standards noted in the benchmark. Referred to as ?Tier 2" standards, they are to begin as early as the 2004 vehicle model year. The CAA requires the EPA to conduct a "Tier 2" study to determine if additional reductions in emissions from light duty gasoline vehicles (LDGV) and light duty gasoline trucks (LDGT), beyond the Tier 1 standard reductions required in the CAA, are necessary to meet the Ozone NAAQS. The required study is now complete, and it is now part of the Tier 2 standards that are scheduled to be proposed this year. Since this rule is still under review, it is uncertain if the standards as currently prepared by the Agency will be those that are promulgated. The version of the Tier 2 standards currently in the baseline for this report is therefore the same version that was applied in the Ozone and PM NAAQS and proposed RH target program RIA in 1997. The assumptions used in the analyses in this report result in significantly fewer emission reductions than those being proposed in the Tier 2 rulemaking. Thus, mobile source controls applied in this analysis are likely to be required by other rulemakings and the costs, benefits, and economic impacts of meeting these illustrative progress goals would be overstated by some degree. Motor vehicle sales statistics indicate that light duty trucks are becoming a greater proportion of the light duty motor vehicle fleet. At the same time, they are subject to less stringent exhaust emissions standards than passenger cars. Further, the heavier categories of light-duty trucks (those with a GVWR of 6,000 to 8,500 pounds) are not included in the NLEV program, while the lighter categories could have emissions standards tightened to more closely match those for passenger cars.

The following limits are assumed in the RH baseline as listed in Table 5-3 for passenger cars and light duty trucks beginning with the 2004 model year:

Table 5-3
Standards for Tier II Version in Regional Haze Baseline

Category	NMOG (grams/mile)	NOx (grams/mile)
LDGV	0.075	0.20
LDGT1	0.075	0.20
LDGT2	0.100	0.20
LDGT3	0.195	0.40
LDGT4	0.195	0.40

These standards are chosen to maximize the NOx benefits of the potential Tier 2 program. The non-methane organic gases (NMOG) and NOx standards used in this analysis for the LDGV and LDGT1 categories are identical to those in the NLEV program. The standards for the LDGT2 category are the same for NMOG, but a tighter NOx standard is used in this analysis. The heavier categories of light duty trucks, LDGT3 and LDGT4 categories, are not included in the NLEV program. The LDGT3 standard included in this analysis is less stringent than the equivalent California LEV standard for NMOG but more stringent for NOx. The LDGT4 standard is identical to the equivalent California LEV standard for NMOG but more stringent for NOx. Emission reductions associated with these standards are modeled using MOBILE5a with alternate basic emission rate equations.

Costs for these standards in the final RH rule baseline are based on estimates developed by the California Air Resources Board (CARB) for its LEV program. The CARB estimates the incremental per vehicle cost to achieve LEV standards at $120. Because the LDGV and LDGT1 standards are equivalent to the NLEV standards, no incremental cost is assumed for these vehicles. For the LDGT2 category, it is assumed that because only the NOx standard is further tightened, the additional cost will be half of CARB’s estimate for achieving the LEV standard, or $60 per vehicle. For the LDGT3 and LDGT4 categories an incremental cost of $120 per vehicle is assumed.

There are six mobile source control measures in the control measure database employed for the analyses of meeting the illustrative RH progress goals. They are: on-highway heavy-duty diesel vehicle program (HDDV), the non-road HDDV, the fleet inherently low emission vehicle program (fleet ILEV), high enhanced inspection and maintenance (I/M) program, and a transportation control program (TCP). The on-highway HDDV program applies to HDDVs with a gross vehicle weight rating (GVWR) of more than 8,500 pounds (lbs), while the nonroad HDDV applies to nonroad HDDVs above the same GVWR. The fleet ILEV, which is applied to light-duty gasoline vehicle with a GVWR under 8,500 lbs. is based on California emissions standards that are more stringent than the standards required in the CAA (referred to as “Tier 1" standards). The high enhanced I/M program is a control measure applied to light-duty gasoline vehicles with a GVWR under 8,500 lbs that tightens the requirements of current I/M programs applied nationally. The transportation control program used in this analysis is based on a set of voluntary measures applied as part of several innovative pilot programs that reduced the vehicle miles traveled (VMT) in a number of locations nationwide.

5.5.2 Local Mobile Source Control Measures

In this analysis, local mobile source control measures include heavy-duty engine retrofit programs, transportation control programs (TCP) designed to reduce VMT, clean engine fleet vehicles, and clean burning fuels. Each of these control measures is discussed in this section.

5.5.2.1 *Heavy Duty Engine Retrofit Programs*

Heavy duty engine retrofit programs can be applied at the local level to target emission reductions where they are most needed. Heavy duty engines for both highway and nonroad vehicles are a significant source of PM emissions. Tighter standards for new engines (Tier 2 or Tier 3 standards depending on engine size classification), which are included in the 2010 CAA baseline (the benchmark for these RH analyses), will help to reduce PM emissions from the heavy duty highway and nonroad fleets. However, because of slow fleet turnover rates for these engines, significant numbers of older engines certified to less stringent emissions standards will still be present in the fleet in 2015. One way to reduce the emissions of these engines is to upgrade or retrofit them with after-treatment devices. Upgrades or retrofits can be done when the engines are being rebuilt, which typically occurs at least once during their lifetimes.

The EPA has experience with these programs through the existing Urban Bus Retrofit Program. However, the costs and emission reductions associated with broader application of these programs is somewhat uncertain, particularly for nonroad engines. It is assumed that both highway and nonroad engines subject to the program can achieve a 25 percent reduction in PM emissions at a cost of $1,000 per engine. These estimates are based on EPA's experience to date with the existing Urban Bus Retrofit Program, which has achieved similar reductions at similar cost. The number of engine retrofit candidates will vary based on the design of the local program. Based on the limited period preceding the analysis year 2015 over which these programs can be phased in, it is assumed that 25 percent of all pre-1994 highway heavy duty engines still in the fleet in 2010 can be retrofitted. For nonroad engines, it is assumed that 25 percent of all pre-2001 engines can be retrofitted by 2010 (Dolce, 1997).

5.5.2.2 *Transportation Control Measures*

It has been shown in several pilot projects, most notably in the Portland, Oregon metropolitan area, that implementing innovative, voluntary transportation measures can directionally influence the growth rate of VMT. Due to the voluntary nature of these programs and the wide variety of transportation measures available to States and localities, it is difficult to estimate specific reductions in the growth rate of VMT, and hence emission reductions attributable to these measures. However, there is general agreement among expert sources that a nationwide 5 percent reduction in the rate of VMT growth over a 10-year period is reasonable. For instance, an area that had 2.0 percent annual VMT growth would instead experience 1.9 percent growth. The cost of transportation control measures (TCMs) is not easily estimated and will vary depending upon the collection of measures employed and many area-specific factors. In this analysis, the cost of an area-specific package of TCMs that reduces the growth rate of VMT by 5 percent is assumed to be $10,000 per ton of NOx reduced. (Dolce, 1997)

5.5.2.3 *Fleet ILEV Program*

The use of cleaner fuels could be a source of additional emission reductions for the light duty vehicle category. However, estimating the amount of additional exhaust reductions associated with burning cleaner fuels when compared to normal gasoline fueled vehicles already meeting the baseline NLEV standards is uncertain. Certain liquid fuels that have relatively low vapor pressures or gaseous fuels that must be contained in pressurized fuel systems provide clear advantages over normal gasoline with respect to evaporative emissions. Vehicles that properly use these fuels and, as a result, have zero evaporative emissions, are referred to as ILEVs.

The analysis in this report assumes that localities could impose requirements that all centrally-fueled light duty fleet vehicles meet ILEV standards by 2015. These ILEVs are assumed to have no evaporative emissions, to comprise 3 percent of the light-duty vehicle and truck VMT, and to have a lifetime incremental cost of $1800 per vehicle. (U.S. EPA, 1992a)

5.5.2.4 *Reformulated Gasoline*

Beginning with the year 2000, more stringent standards will take effect for all reformulated gasoline (RFG) areas. These standards require that VOC emissions be reduced by about 27.5 percent, and that NOx emissions be reduced by 6.8 percent, on average, relative to the emissions of baseline gasoline as defined in the CAA. These more stringent standards, called Phase II standards, also require a 21.5 percent year-round reduction, on average, in air toxics, which is based on mass reductions in benzene, formaldehyde, 1,3-butadiene, acetaldehyde, and polycyclic organic matter (POM). The EPA had previously determined that the overall cost for Phase II RFG, incremental to the cost of the baseline fuel and including the required addition of oxygen and removal of much of the benzene, would be 5.1 cents per gallon (U.S. EPA, 1993).

Based on the subsequently false assumption that most major cities east of the Mississippi River would be out of attainment for the proposed Ozone NAAQS, the EPA assumed RFG would be chosen as a control strategy over most of this region of the country. The estimated incremental cost for implementing the RFG program under this scenario is 6.7 cents per gallon, reflecting the higher costs associated with reformulating a greater fraction of the gasoline pool. However, based on the benchmark projection, the number of areas which ultimately might use the RFG program represent a much smaller portion of U.S. gasoline consumption than originally assumed.

In addition, the manner in which the full costs of the RFG program are allocated to either VOC control or to NOx control results in the program appearing to be less cost effective than previous EPA projections have indicated. When finalizing the RFG program, EPA evaluated the costs of the VOC and NOx standards independently using only the incremental cost associated with meeting each standard (U.S. EPA, 1993). The EPA thus concluded that the Phase II RFG NOx standard employed in the benchmark for this report is cost effective (about $5,000 per ton of NOx controlled), while the VOC standard similarly is determined to be cost effective (about $500 per ton of VOC reduced). The remaining costs of the program were attributed to the toxics reductions achieved. Clearly, in this RIA where the full costs of the program in the benchmark are allocated to either NOx or VOC control, the cost-effectiveness value will be larger than shown in previous work. The EPA does not view these costs to be inconsistent with previous work because the bases for the analyses are so different.

5.6 Analytical Limitations, Uncertainties, and Potential Biases

The cost and emission control effectiveness estimates for the control measures used in this analysis are developed using inputs from several reliable data sources and using best engineering judgement. Cost and effectiveness values may vary significantly among specific applications due to a variety of source-specific variables. Air pollution officials in airshed planning regions will decide exactly how the area-specific control measures are applied. Their actions will ultimately determine the actual costs and effectiveness of these measures, and of the overall air pollution control program.

The NPI characterizes the emission sources that may potentially be affected by control measures. Because of the vast number of emission sources for most pollutants (e.g., VOC emissions from filling gasoline storage tanks), data are not developed for each individual emission source. Control measure cost estimates are developed by applying cost algorithms to the available information in the NPI. The lack of detailed information in the NPI reduces the level of confidence in the cost estimates, but does not necessarily introduce systematic bias.

For some point source categories appearing in the NPI, data are available for a range of model plant sizes. In such cases, cost equations are developed relating size of the emission production activity to costs. For example, costs for flue gas desulfurization (FGD) scrubbers on SO_2 emission sources are based on a spreadsheet model that relates input parameters such as stack gas flowrate and annual operating time to costs for FGD scrubbers. These variables are available for many point sources in the NPI. For other point source categories and all area and mobile source categories, an average incremental cost-effectiveness value (dollar per ton of emission reduction) or other similar average cost value (cents per gallon of gasoline) is used. Costs are developed at the source category level for these sources because the readily available data do not provide enough information to differentiate costs by emission source size or other cost differentiating parameters. Another limitation relates to many of the PM area source control measures. For many of the area source PM control measures it is sometimes necessary to estimate the PM_{10} cost effectiveness from total suspended particulate (TSP) cost-effectiveness data.

Another source of uncertainty is associated with the fact that costs are estimated for a projected year of 2015 (in 1990 dollars). The projected level of emissions and level of learning and technological innovation that will occur in emission control industries between now and 2015 are inherently uncertain.

Another limitation associated with the cost estimation procedure involves the transfer of cost information, which was developed for other purposes, to this analysis. The extent of this limitation is largely a function of the available cost data. Given the vast number of control measures and potentially affected sources, it is not possible to develop detailed control cost estimates for each individual emission source or even each source classification code (SCC). Cost information is taken from or developed using EPA costing manuals and guidance documents, State and local agency attainment plans, background documents for NSPS, and other sources. Cost methods, where they are adequately documented, are reviewed to verify that correct procedures are used. However, some potential data sources provide emission reduction and cost estimates with little or no supporting documentation. For this reason, several measures lacking sufficient supporting documentation are excluded from this analysis. The extent to which such measures can achieve genuine reductions at the costs estimated is unknown.

In addition, many of the available cost estimates are based on cost studies that were conducted in the 1980s. For this analysis, these estimates are adjusted to reflect 1990 price levels using an appropriate price index. It would be possible, with a significant additional time commitment, to develop current estimates that would reflect any production-oriented advances that may have affected these costs (e.g., any scale production/cost effects that may have occurred from increased demand for the control technology). As noted above, no attempt is made to account for the potential effects of future technological innovations.

5.7 References

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